ABSTRACT
The Nation's Orphan Nuclear Stockpile

By: J. Andrew Tompkins, CHP and L.E. Leonard, P.E.

Today within the US there exist over 15 kilograms of transuranic isotopes, excess to anyone's needs, except perhaps to the needs of someone bent on doing harm. Most, but not all, of these materials are under license authority, but because they have no value to their owners, they are often stored with a minimum, and in some cases no, security at all. This orphan stockpile is primarily made up of three isotopes - Pu-238 and 239 and Am-241 - all materials with serious destructive potential if acquired and misused. The orphan stockpile exists in limbo, a financial, legal, and security burden to its custodians, without any path to final disposition. How did this stockpile come into being, and what can be done to eliminate it as a potential threat? These are the questions this paper will address.

The paper describes the introduction and use of actinide-bearing radioactive sealed sources within the US and follows their proliferation from the unique tools for atomic research in the 1950s to ubiquitous industrial and medical applications of the 70s and 80s. The chronology spans nearly half a century of development in beneficial uses of nuclear materials and identifies the events that, like a disease, first began to confound the value of radiation source technology used in industry and research, and has advanced to the point of suffocating the future by the creation of the onerous orphan stockpile.

The paper proceeds to describe recent events that have illuminated the potential risk that the orphan stockpile represents. It discusses plans to accelerate the recovery of the backlog of the largest excess sealed sources in the US which make up the stockpile and how, it is hoped, that within the next 18 months, this potential threat can be eliminated. Finally, it discusses how the elimination of the legacy of the orphan stockpile might contribute to a revived sealed source industry and a renewed interest in applying nuclear material technology to today's societal needs.

The Nation's Orphan Nuclear Stockpile
By: J. Andrew Tompkins, CHP and L.E. Leonard, P.E.

Scope of the Problem

Today within the U.S. there exist over 15 kilograms of transuranic (TRU) isotopes, excess to anyone's needs, except perhaps to the needs of someone bent on doing harm. Most, but not all, of these materials are under license authority, but because they have no value to their owners and no path to disposal, they are often stored with a minimum, and in some cases no, security at all. This orphan stockpile is primarily made up of three isotopes – Plutonium (Pu)-238 and 239 and Americium (Am)-241 - all materials with serious destructive potential if acquired and misused.

The 15-kg of TRU material is contained in approximately 5,400 sealed sources. This information is summarized from the sealed source database maintained by Los Alamos National Laboratory's - Off-site Source Recovery Project (fig 1-3). This database is the only repository of excess sealed source information by owner, location, source size, and activity in the US, since neither Nuclear Regulatory Commission (NRC) or Agreement State Authorities maintain this information at an individual licensee/sealed source level. The mass distribution[1] of these isotopic sources is as follows:

Pu-238: 1 kg
Pu-239: 9 kg
Am-241: 5 kg

Why are there so many TRU Sealed Sources

In the 1950s the Atomic Energy Commission (AEC) began to fabricate and distribute PuBe sealed sources under a Loan Lease Program. The goal of the program was to provide research and teaching tools to those who would shape the future of nuclear energy. These sources were loaned since it was not possible for private individuals to own plutonium sealed sources under the Atomic Energy Act (AEA) as amended in 1954. Individual sealed sources containing special nuclear material (fissile) were to be tracked and transfers of material documented.

The AEA was further amended in the mid 1960s to permit private ownership of special nuclear material, which included plutonium/beryllium (PuBe) sealed sources. Regulations were issued in 1967 to establish specific material control and accounting procedures for licensees[2].

In the mid 1990s DOE sought to eliminate the Loan Lease Program and made an effort to recover PuBe sealed sources or to transfer them to the ownership of the responsible licensees. The closeout of the AEC's Loan Lease Program was not well structured[3]. Many of the licensees possessing PuBe sources were not contacted and offered the option to transfer the sources to DOE custody. Transfers that did occur were poorly documented. DOE had tracked the location of large plutonium sealed sources as an adjunct to the Nuclear Materials Management and

[1] Identification of Nuclear Material in the US that Pose Potential Vulnerabilities for a Terrorist Threat, June, 2002.
[2] Plutonium, The First 50 Years, DOE/DP-0137.
[3] Accounting for Government Owned Nuclear materials Provided to Non Department Domestic Facilities, DOE/IG-0529, October, 2001)

Safeguards System (NMMSS) database until 1985. When NMMSS funding was severely cut in the 1980s, any attempt to independently track transfers of sealed sources was disrupted.

In the mid 1960s, AmBe sealed sources became available, with Am-241 supplied through AEC Isotope Sales programs, and were commercially produced. Since Am-241 had a much higher specific activity than Pu-239, the neutron sources produced were much more compact and useful for industrial purposes. The Americium was tracked by NMMSS only to the point of manufacture. Once manufactured and distributed, the Am-containing sealed sources were not tracked by the AEC, since at the time they were not thought to be fissile and therefore were not a proliferation threat. Of the many manufacturers of PuBe and AmBe sealed sources, only two are still in the business.

Production records for individual sealed sources from the defunct businesses (NUMEC, Parkwell Laboratories, Monsanto Research Corp., Gulf Nuclear, etc.) are very rare, since there was no regulatory requirement for document retention at either the NRC or Agreement State level. Thus, there is no good record of how many AmBe sealed sources were manufactured, their activity, or initial owner. This number could have been derived statistically if the total quantity of Am-241 produced and sold were known. However, DOE (AEC) Isotope Sales records were purged in the mid 1980s and that documentation no longer exists[4]. From a science and technology point of view, the commercialization of TRU sealed sources was one of the greatest successes of the AEC. The economic advantages gained from nuclear oil well logging alone could justify the commercial use of alpha-emitting isotopes. However, in the wake of 9/11 we may yet find that the lack of rigor to appropriately regulate and provide end of life recovery of these same sealed sources was one of its greatest failures.

Today, we do not know exactly how many AmBe sealed sources were fabricated nor to whom they were distributed. This is less the case with Pu/Be sources, but the uncertainty remains high. How many are in use, and how well they are protected by their owners, remains a nagging question. On the other hand, we do know something about the inventory of such sources that are no longer wanted, or needed. One of the best attempts to document the number of large sealed sources with no disposal path was the statistical analysis of sealed sources that would qualify as Greater Than Class-C Low-Level Waste (GTCC) in the US by Harris of INEL[5]. This report estimated the number of TRU sealed sources that would end up as GTCC at some future time. Beginning with this report, and adding additional independent research and a survey of the industry, the OSR Project at LANL has derived and estimated the total number of TRU sources needing recovery and disposal from the licensed community over the current decade at about 18,000 units. Of these, LANL has recovered about 3400 to date; over 5,000 remain identified awaiting recovery, and the balance remain to be individually identified.

Where are these Sealed Sources

The excess sources themselves are located in 48 of the 50 states, with a high concentration of Am-241 in Texas (Fig. 1-3). This wide distribution indicates the general industrial utility of devices incorporating radio-isotopic sealed sources. These sealed sources were used to measure material thickness, tank content levels, moisture/density, asphalt content,

[4] Personnal communication from Rocky Cline of the DOE Istope Sales Office (Y-12).
[5] *Characterizaton of Greater than Class C Sealed Sources*, September 1994, DOE/LLW-163, Vol. 1-3.

minerology/porosity/petroleum content, nuclear medicine imaging markers, and even as nuclear pacemaker power supplies. The ubiquitous nature of AmBe moisture density gauges in civil engineering work ensures that almost every major road project in the US has at least one, if not several, of these devices. The high concentration in Texas indicates the prolific use of these sealed sources in the petroleum industry.

Origins of the Problem

The orphan stockpile of TRU sources exists in limbo, a financial, legal, and security burden to its custodians, without any path to final disposition. How did this stockpile of excess material come into being?

By the National Low Level Radioactive Waste Policy Amendments Act of 1985 (PL 99-240) Congress assigned DOE the responsibility for disposal of all Low-Level waste from licensed activity that exceeded the Class C Low Level Waste limit established by NRC in 10 CFR 61.55. Codification of the law indicated that all licensed TRU material with an activity concentration greater 100 nCi/gram and a half life longer than 20 years was GTCC material and the responsibility of the DOE. Effectively, none of the TRU sealed sources in the US larger than 0.5 mCi have, from that time forward, had a legal disposal path.

By 1987 DOE presented a report to Congress on GTCC stating, "DOE expects to have a program in place for accepting GTCC LLW for storage within two years"… "The small volume of GTCC materials is currently being managed safely by NRC and EPA. The issue is therefore not one of providing safe storage, but of providing safe disposal"[6].

By 1993 it had become clear that while disposal was the final issue, interim storage could not be ignored indefinitely: "Requirements of PL 99-240 are specific to disposal. However, since 1987 DOE has recognized that its program to provide GTCC LLW disposal capacity must also have the capability to provide storage. It is believed that some generators may not be able to maintain GTCC LLW in storage until disposal capability is available. In addition it is recognized that waste having similar characteristics to GTCC LLW has been mishandled and in some cases abandoned"[7].

Starting in 1993, DOE & NRC had agreed to a joint policy of response to TRU sealed source incidents in the public sector. NRC would request prioritized response from DOE to TRU sealed source incidents. Throughout the rest of the decade DOE and NRC formalized this working relationship into a Memorandum of Understanding (MOU)[8].In the same year as the MOU, DOE revised its sealed source recovery and management project. DOE-Albuquerque Operations Office under its Waste Management Division directed that the OSR Project be organized at LANL to "more aggressively" initiate recovery and safe storage of TRU sources. This recovery effort has managed to increase the number of sources recovered each year until FY-2002 when budget cuts scaled back the effort. In the months since 9/11 the project has managed to recover only some 400 plus sealed sources as compared to over 3000 in FY 2001.

---

[6] *Recommendations for Management of GTCC Low Level Radioactive Waste, Report to Congress in response to Public Law 99-240*, DOE/NE-0077, February 1987.
[7] GTCC LLW Radioactive Waste: Program Assessment, RAE-9208/2-1, September 1993).
[8] Reference DOE-NRC MOU of 1999.

NRC, on the other hand, has not ignored the issue. In a January 2002 letter[9] to DOE, NRC declared that additional actions to recover TRU sealed sources with no disposal outlet were warranted since these materials represented a potential vulnerability. The letter went on to state that that it might be appropriate to compress the OSR Project recovery schedule into 18 months.

Where Can These Sources Go

DOE sponsored LANL to collect about 1,000 large Pu-239 sealed sources from 1979-1998. These sources were chemically processed and the plutonium recovered as a low-grade oxide under the auspices of the Stockpile Stewardship Program until 1998. At that time, it became clear that low-grade oxide was a waste with no disposal path and that continuation of the chemical processing could be interpreted as unnecessarily generating commingled waste. Commingling is defined as unnecessary mixing of non-defense and defense generated Pu and Am-241 materials.

The only TRU disposal site in the US is the DOE Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM. The WIPP can only receive defense eligible TRU materials, as defined by Congress, under the terms of the WIPP Land Withdrawal Act of 1993. Under the law, defense eligibility is narrowly defined as TRU material directly derived from nuclear weapons production, naval reactors, or research in these areas. Therefore, there is no disposal pathway for the TRU materials used by the licensed community in industrial and research applications that are now being recovered by DOE. At present, there is no funded program within DOE to establish a disposal path for GTCC TRU sealed sources, although Ines Triay of the Carlsbad Field Office has recently identified the need as a high priority[10]. However, until proposals are translated into concrete action, the orphan stockpile continues to grow.

Why is TRU material a Potential Weapon of Terror

Recent events have illuminated the potential risk that the orphan TRU stockpile represents. The recent arrest of an Al Quaeda operative in Chicago, IL on a mission to acquire a radioactive dispersal device (RDD) in the US shows the imminent threat. The use of radioactive material as a weapon of terror is limited by the physical and chemical form of the material, the type of radiation emitted, and the physical size of the sealed sources available. Physical form relates directly to dispersibility. High dispersibility is necessary for an RDD. Desired characteristics are:

- Availability
- Ease in handling (i.e., non-lethal conversion to desired form)
- Ease of transport (i.e., difficult to detect)
- Easily dispersed
- High fear factor

Monolithic solids such as Cobalt-60 or Iridium (Ir)-192 metals, fused strontium (Sr)-90 or cesium (Cs)-137 salts, or ceramics such as nuclear power plant (NPP) fuel pins present practical operational limitations to terrorists that should not be discussed in this paper. Am-241 and Pu-

[9] Letter from NRC Chairman R. Menserve to R. Card, DOE/EM-1, January, 2002..
[10] Accelerating Clean-up and Closure of DOE TRU Waste Sites, Stratigic Initiative Number 3, Ines Triay, June, 2002

238 and Pu-239 are available in the form of sealed sources and they are more easily shielded for concealment and transport than the big gamma emitters. They can be made dispersible, and as alpha emitters, they have an enormous dose conversion factor. They are at the top of the radio-fear list in the public's perception.

If this discussion of the relative merits of different radioactive materials as a weapon of terror makes you uncomfortable, it should. However, the ready availability of information in 2002 makes it simple to gauge the level of discussion of these matters in the public domain. Our test is very simple. Go on-line to the Yahoo search engine. Type in the words "radioactive material terrorism". Last time we did this exercise, the number of hits was greater than 10,000. Not all 10,000 hits were relevant, but the first several hundred weren't bad. This cat is already out of the bag!

What actions need to be taken

First, all excess TRU sealed sources need to be recovered to safe, secure DOE storage. This will cost about $9.5 million for the 5,400 sources currently on the OSR Project database. No, this expense does not cover building a new facility, doing lots of research, or even getting the material in the WIPP shipping queue.

Second, the WIPP Land Withdrawal Act and other legislation must be changed to allow disposal of all TRU sealed sources in the US's only approved TRU disposal site. The no-defense Am-241, Pu-238, and Pu-239 is identical to its defense eligible cousins and, in most cases, is cleaner and of relatively small volume. The OSR Project estimates the maximum number of 55-gallon drums required to package this GTCC waste in a WIPP compliant configuration to be 1,000. This is about 1% of the total number of TRU, defense-eligible drums currently at DOE sites. Even the Sierra Club[11] does not want to build another TRU waste repository for this material.

Third, support the work that is in progress. The budget of the OSR Project at LANL has decreased dramatically in the last three budget cycles, and the proposed FY-03 budget will permit only a warm stand-by capability, not a vital recovery operation. Recognize that after the first 5,400 sources are collected, the next several thousand additional TRU sealed sources will come out of the woodwork, since there would be a viable recovery and transfer option available.

Conclusion

In conclusion I would point out that this problem has been building up in the US since the early 1980s. Congress tried to address the problem in 1985, but no level of the federal government has given it the priority it should see since 9/11. Current work by the OSR Project can solve a significant portion of the immediate problem, funding permitting. However, without a comprehensive policy to see this excess material all the way to disposal, no single project alone can guarantee a total elimination of risk.

Continuing to ignore the TRU sealed source problem only provides the waiting stockpile for terrorist activity. NRC, DOE, EPA, and Congress must work together to solve this TRU sealed source problem. Even if we take all appropriate action tomorrow, we cannot eliminate the threat

[11] Letter to the OSR Project from the Pajarito Chapter of the Sierra Club in New Mexico.

of radioactive material terrorism in the US, we can only greatly reduce the probability and the ease with which this activity might occur.